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POLYSTICTUS VERSICOLOR AS A WOUND PARASITE OF CATALPA

NEIL E. STEVENS

(WITH PLATES 74 AND 75, CONTAINING 4 FIGURES)

The wood rot of living catalpa caused by *Polystictus versicolor* is the only really serious disease of the catalpa yet reported. *Polystictus versicolor* is, of course, one of the most common wood-rotting saprophytes, but as was pointed out by von Schrenk (8) in 1902, it becomes on the catalpa a dangerous wound parasite, growing with great rapidity in living trees, spreading up and down the trunk from the point of infection, out into the branches and even into the roots (8, p. 53). On living trees the fungus produces sporophores in great abundance, but is rarely found fruiting on dead catalpa; a fact which apparently led von Schrenk to the conclusion that *P. versicolor* is unable to grow on dead catalpa wood and that even when growing in a living tree stops its growth when the tree is cut (8, p. 54). As the writer has shown in a recent paper (7), however, *Polystictus versicolor* may continue to grow on dead catalpa wood and under favorable conditions may produce normal sporophores in considerable quantity.

The report of von Schrenk on the diseases of the hardy catalpa was based largely on observations in two large plantations in Crawford County, Kansas, the Hunnewell and Farlington plantations. In fact, these two plantations, together with the other large plantations in the eastern portion of Kansas, have served as the basis for most of the work done in this country on the artificial cultivation of the hardy catalpa. During the past year (1911–1912) the writer has investigated the wood rots of the catalpa in this region, with special reference to second growth stands. In the course of this work it has become evident that coppice shoots on partly decayed stumps are much less readily infected than are branches of a partly decayed trunk, and that there is an apparently constant relation between the presence of a decayed area in the trunk and the formation of tyloses in the outer wood. While the data on these points are by no means so complete as to make possible wholly satisfactory explanations of the conditions mentioned, the observations already made seem of sufficient interest to make their publication worth while.

INFECTION OF COPPICE SHOOTS FROM DISEASED STUMPS

When the large plantations referred to above were first cut over, the trees were from twenty to twenty-four years old. At that time many of the stumps were rotten at the center. Undoubtedly they were affected in most cases by *Polystictus versicolor,* for many of the trees on both the Farlington and Hunnewell plantations were seriously decayed by this fungus at the time of cutting, and in certain portions of these plantations many of the stumps are now bearing numerous sporophores of this species.

Yet sprouts from these partly rotted stumps, even from those which bear sporophores, show no external evidences of fungus infection and are as well developed as those from sound stumps. Six-year old sprouts on partly rotted stumps are fully as large as those of the same age on sound stumps and bear as many seed pods. To determine whether these sprouts were actually free from fungus infection or whether the fungus was present and would finally result in the weakening and death of the sprout, the writer spent several days in a study of the second growth at the Hunnewell plantation. Fortunately for this work, eighty acres of six-year old second growth was sprouted only a few weeks before his visit (March, 1912), and the sprouts were still lying where they had been cut.

A careful examination of this eighty-acre tract showed that while only a very few of the shoots from partly decayed stumps showed any external evidence of fungus infection, a large proportion were rotted at the heart. On the other hand, practically none of the shoots from sound stumps showed decayed areas. In one forty-acre tract nearly two hundred stumps were counted which bore sporophores of *Polystictus versicolor* and the sprouts from nearly all of these showed rotten hearts. On fifteen large decayed stumps which bore six or more good sized sprouts, every sprout showed a considerable decayed area. In the entire eighty acres, however, only three sprouts were found which bore sporophores.

There can be little question that the decayed sprouts were infected from the stump. In the great majority of cases, the sprouts showed no injury through which the fungus might have entered, and the decayed area was always largest at the base of the sprout. Moreover, no such decayed areas were found in sprouts from sound stumps. The decayed area generally occupied the center of the sprout and extended up from the base for some distance, usually less than two feet and very rarely as much as three. Figs. 1 and 2 show two sections through an unusually large sprout from a stump which bore a large number of sporophores. The section shown in fig. 2 was cut about six inches above the stump and that in fig. 1 two feet above the stump. These figures show that the growth of the sprout had been very rapid, much more rapid in this case than in the majority of the sprouts from sound stumps, and that the action of the fungus was limited thus far to a comparatively small portion of the sprout. How rapid the further progress of the fungus may be cannot, of course, be determined at present, but it is certain that this fungus frequently spreads much more than two feet a year in living catalpa trees. (See 8, p. 53.)

Why decay had not progressed further is a most interesting question. There can be no doubt that the fungus both in the stump and in the sprout was alive and in a vigorous condition at the time the trees were examined. Pieces of the rotten wood placed in a moist chamber showed in a few days a dense growth of characteristic mycelium. Moreover, it is entirely probable that the stumps which produced the rotten sprouts were themselves infected before the trees were cut. Many of the stumps certainly were affected when the plantation was cut over and it is difficult to suppose that the fungus died in these stumps and that they or other stumps were infected later. Infection of sound catalpa wood does not easily occur and the stumps in question were most rotten at the center, exactly the condition found in the stumps of badly rotted trees.

It is possible, of course, that the progress of the fungus in these shoots was slower than in older trees. But even if considerable allowance is made for this assumption, it seems more than probable that these shoots did not become infected for some time, probably several years, after they started. That *Polystictus versicolor* is capable of living for that length of time even without much growth cannot be doubted, for Bayliss (1, p. 20) has proved that the mycelium of this fungus can retain its vitality in a dried stick for at least four years. Observations at Soldier, Kansas, indicate clearly that *Polystictus versicolor* is capable of attacking seedlings even younger than these sprouts. Certainly the fungus spreads rapidly enough from the trunk of a tree into its branches; and it readily attacks and fruits on one-year old sprouts around the base of a living tree.

It is not entirely clear, therefore, why these coppice shoots were not attacked and killed much earlier; but it seems possible that this temporary "immunity" may be due to the rapid growth of the sprouts. Both Hartig and Sorauer have cited examples of wound parasites which, although capable of causing the decay of woody portions growing at an ordinary rate, are unable to attack *rapidly* growing parts. Hartig (3) states that in the case of an oak attacked by *Armillaria mellea,* one may readily observe that the parasite has not developed equally, but usually toward one side. According to him, the development is arrested when the fungus comes to a region directly under the influence of a vigorous shoot.

Sorauer (6, p. 192) discusses the parasitism of *Nectria cinnabarina* and states that this fungus is apparently unable to attack sound, rapidly growing tissue of the host. This writer has observed in the case of small trunks of *Acer Negundo* attacked by *Nectria cinnabarina,* that in the spring the progress of the fungus is stopped by the more vigorous growth of the wood. Sorauer further states that in larger trunks where a sound side shoot has developed, the fungus in the main trunk kills the tissue up to the part which is under the influence of the vigorous side shoot and there remains stationary. It seems possible that something like this occurs in the case of diseased catalpa stumps which have given rise to vigorous coppice shoots. That is to say, that the fungus may be held in check for a time by the rapid growth of the new tissues.

An examination of such stumps as that shown in fig 4, which is typical of a number found on the Hunnewell plantation, lends support to this idea. •This photograph was taken from a section through the base of a stump which bore sporophores of *Polystictus versicolor* and which had produced a sprout of average size. It will be noted that the fungus has destroyed practically all of the wood of the original stump but that the second growth is as yet untouched. That the fungus was in a vigorous condition was proved by placing the stumps in a moist chamber, where mycelium developed on the cut surface in a few days.

Unfortunately, no complete data are at hand by which the rate of growth of catalpa coppice may be compared with that of seedlings. For the first few years the growth of coppice shoots greatly exceeds that of seedlings, but whether this accelerated growth is sufficient to check the progress of the fungus cannot, of course, be determined at present. It is apparent, however, from an unpublished report on the catalpa plantation at Farlington, made in 1911 by Mr. Charles A. Scott, Kansas State Forester, that in this plantation, at least, the accelerated growth of the coppice shoot does not last more than three or four years and that the succeeding growth may be even less than that of normal seedlings. A comparison of his data with that given by Hall (2) for the same plantation in 1902 shows that second growth dominant trees nine years old do not exceed in height average seedling trees of the same age. As the data also show that the rate of growth of second growth trees was considerably greater than that of seedlings during the first three of four years, the subsequent growth of the second growth trees must have been enough slower to make up for what they gained in the first few years.

It is by no means certain that there is any relation between the fact that the shoots grow more rapidly for the first few years and that they are apparently for a time immune to the attacks of the fungus, but the probability is at least great enough to make continued observation on this point worth while. At any rate, the length of time for which the accelerated growth of coppice shoots continues, and the limited extent of the decayed areas in six-year old sprouts harmonize readily with the idea that these shoots were not attacked until the most rapid growth had ceased. This makes the assumption that there was some causal connection between the rapid growth and the temporary immunity seem not improbable.

CORIOLELLUS SEPIUM.—Although no other dangerous fungus parasites of the hardy catalpa have been reported, the writer has found several species growing to some extent both on living and on dead catalpa (7, p. 116). Next to *Polystictus versicolor,* the species which the writer has most frequently found fruiting on catalpa stumps is *Coriolellus Sepium* (Berk.) Murrill (*Trametes Sepium* Berk.). While this fungus was not present in sufficient abundance to be considered at all important from an economic standpoint, it is interesting to note that the relation of the fungus in the stump to the coppice shoot was apparently the same as in the case of *Polystictus versicolor.* That is, the fungus although well developed and in vigorous condition in the stump, does not readily attack the shoot. Fig. 3 shows a section through the base of a stump which bore numerous sporophores of *Coriolellus Sepium* and had given rise to a six-year old coppice shoot of average size. It will be noted that the fungus had destroyed a considerable portion of the stump but had not entered the sprout.

DEVELOPMENT OF TYLOSES NEAR A DECAYED REGION

In sections made for the purpose of studying the effect of the fungus on the wood, an interesting relation between the presence of the fungus and the occurrence of tyloses was noted. This relation was observed in the wood of both seedling trees and coppice shoots; and was so striking and constant that it seems that there must be some causal connection and that the presence of a decayed region in a trunk may have a direct bearing on the development of tyloses.

Tyloses were present to some extent in all pieces of catalpa examined but a marked difference was evident between the number of tyloses present in sound and in infected wood. The difference appears both in the number of tyloses present in each annual ring, and in the age of the wood when tyloses first appear. In normal catalpa wood tyloses are found almost exclusively in the larger vessels of the spring wood, and even in these they are more or less scattering, many of the vessels containing no tyloses and others being only partly filled. Tyloses first appear in the second ring from the bark, that is, they are found to a very limited extent in two-year old wood. They are more numerous, of course, in wood which is three- or four-years old, but do not occur in sufficient numbers to hinder very seriously the flow of water.

When the outer portion of a trunk which is rotten at the heart is examined, however, tyloses are found filling practically every vessel of the spring wood and occurring to a considerable extent in the vessels of the summer wood. Moreover, there are practically as many tyloses in the two-year old wood as in the five- or six-year old wood. This is the case even when the rotten portion of the trunk is at some little distance from the two-year old wood, often as much as four or five annual rings. Such a condition means, of course, that even the two-year old wood in badly diseased trees is of practically no use for water conduction. It seems probable that the presence of these tyloses and the consequent obstruction to the flow of water would result in the earlier death of the parenchyma cells in these outer annual rings. It seems possible also that these outer rings would then be more readily attacked by the normally saprophytic *Polystictus versicolor,* and that the formation of tyloses may play some part in the invasion of the sap wood by the fungus.

It would, of course, be unsafe to assume without further proof that this markedly increased development of tyloses is due to the fact that part of the trunk is decayed. But Hartig (4, p. 235) observed that "when the wood of a dicotyledonous tree is exposed by a wound the vessels become completely plugged up by tyloses," and there is considerable resemblence between this condition and that found by the writer in partly rotted catalpa trunks. If, as is generally believed (5), the formation of tyloses occurs when the pressure in the vessels becomes less than that of the adjacent parenchyma cells, then anything that reduces the pressure in the vessels while the parenchyma cells are alive would tend to increase the number of tyloses. Whether the presence of a considerable decayed area would occasion any reduction of the pressure in the vessels and thus result in the great increase in the number of tyloses which occurs, is by no means certain but it seems to offer the only explanation of this interesting condition.

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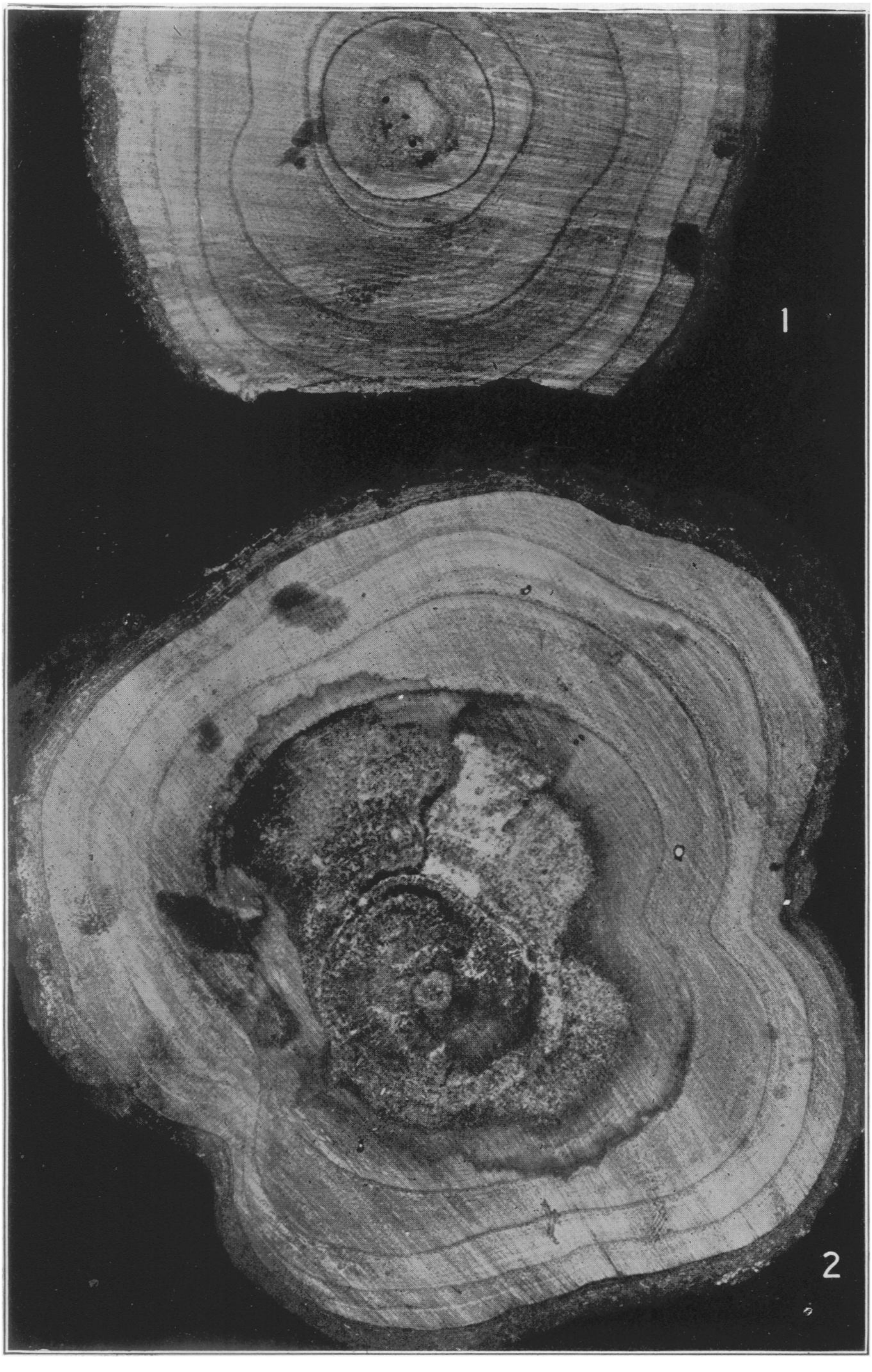
EXPLANATION OF PLATES LXXIV AND LXXV

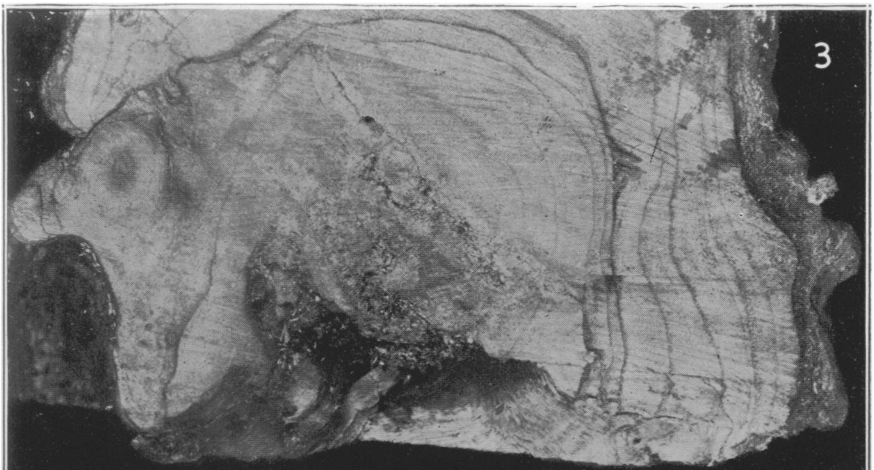
Figs. 1 and 2. Sections of a large six-year-old catalpa sprout on a stump which bore sporophores of *Polystictus versicolor.* The section shown in fig. 1 was taken two feet from the stump, and that shown in fig. 2, six inches from the stump. × ¾.

Fig. 3. Section of the base of a small catalpa stump which bore sporophores of *Coriolellus Sepium* and had produced a normal coppice shoot. × ¾.

Fig. 4. Section of the base of a catalpa stump which bore sporophores of *Polystictus versicolor* and had produced a normal six-year-old coppice shoot. × ½.



POLYSTICTUS VERSICOLOR ON CATALPA



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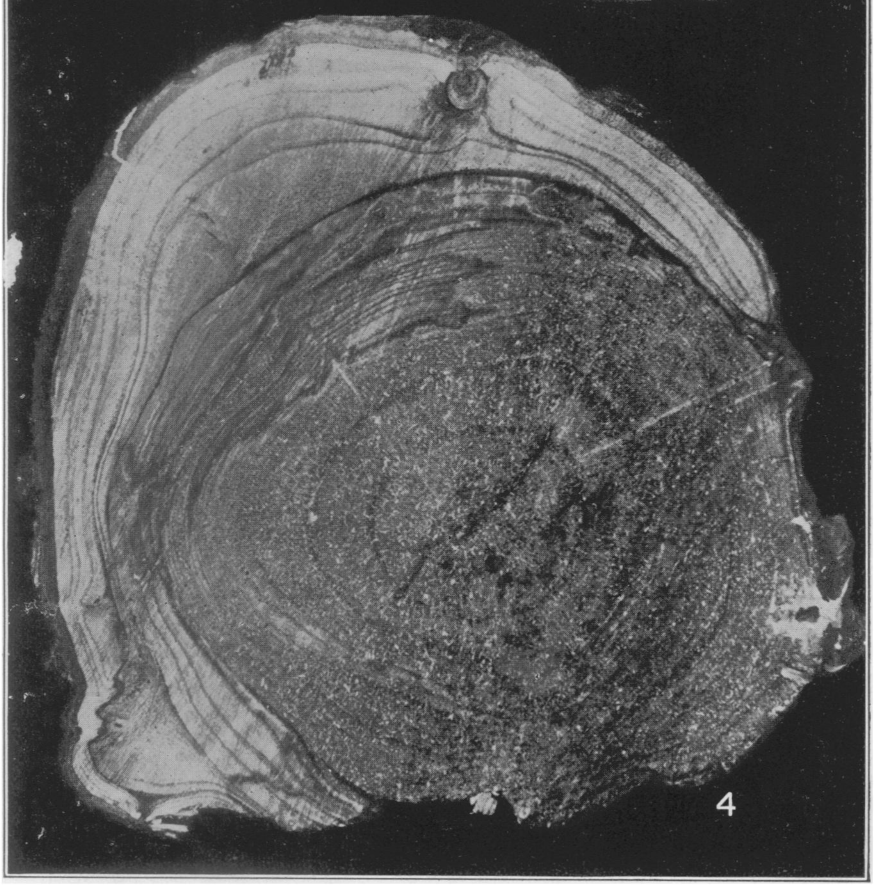

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POLYSTICTUS VERSICOLOR ON CATALPA